BASE-FLOW CHARACTERISTICS OF SEGMENTS OF THE PINEY RIVER, AND EAST AND WEST PINEY RIVERS, DICKSON AND HICKMAN COUNTIES, TENNESSEE

V. Jeff May

U.S. GEOLOGICAL SURVEY
Open-File Report 85-155

Prepared in cooperation with the
CITY OF DICKSON and the
TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF WATER MANAGEMENT

Nashville, Tennessee
1985

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
A-413 Federal Building
U.S. Courthouse
Nashville, Tennessee 37203

Copies of this report can
be purchased from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Lakewood, Colorado 80225

CONTENTS

Abstract 1
Introduction 1
Description of area 2
Study methods 2
Data collection 2
Data analysis 11
Summary 14
Selected references 19

ILLUSTRATIONS

Figure 1. Map showing location of the study area 3
2. Base-flow discharge correlation curve 12
3. August discharge for gaging station Piney River at Vernon (03602500) 15
4. Flow-duration curve for gaging station Piney River at Vernon (03602500) 17

PLATES
(in pocket)

Plate 1. Map showing location of measurement sites on Dickson Quadrangle
2. Map showing location of measurement sites on Texas Hollow Quadrangle
3. Graph showing base-flow profiles of East and West Piney Rivers
4. Graph showing base-flow profiles of Piney River

TABLES

Table 1. List of discharge measurement sites 4
2. Seepage investigation data for August 28, 1984 7
3. Average 3-day minimum discharge, 20-year recurrence interval, at partial-record stations and Vernon gage 13
4. August discharge at partial-record stations and Vernon gage 16

DEFINITION OF TERMS

Terms used in this report to describe streamflow characteristics are defined below:

Average 3-day minimum discharge with a recurrence interval of 20 years (3Q20) is the discharge at 20-year recurrence interval taken from a frequency curve of annual values of the lowest mean discharge for 3 consecutive days. The probability of a discharge being this low or lower in any year is 1 chance in 20 (5 percent).

Base flow in this report is defined as the discharge which occurs during dry weather. Natural base flow is made up totally from ground-water sources.

Cubic feet per second (ft^3/s) is a unit expressing rate of discharge. One cubic foot per second represents a volume of 1 cubic foot of water passing a given point during 1 second and is equivalent to 7.48 gallons per second, or 0.646 million gallons per day for a 24-hour period.

Discharge is the volume of water that passes a given point within a given period of time.

Discharge measurement is a measurement of the volume of water that passes a given point within a given period of time.

Discharge correlation curve in this report is defined as a curve on graph paper showing the relation of discharge at a partial-record station to discharge at a long-term continuous discharge gaging station. The curve is defined by concurrent discharge measurements at the two stations.

Drainage area (DA) of a stream at a specified location is that area, measured in a horizontal plan, which is bounded by topographic divides. Direct surface runoff from precipitation normally drains by gravity into the stream upstream from the specified location.

Gaging station is a particular site on a stream, canal, lake or reservoir where systematic observations of water level or discharge are obtained.

Miscellaneous site in this report is defined as a site on a stream where a base-flow discharge measurement was made for seepage investigations.

Partial-record station in this report is defined as a site on a stream where base-flow discharge measurements are made systematically over a period of several months or years.

Seepage investigation is a field investigation where a series of base-flow discharge measurements are made along a stream channel over a short period of time, usually 1 or 2 days, to define stream discharge and gains or losses in base flow along the stream channel.

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

The following factors may be used to convert the inch-pound units published herein to the International System of Units (SI):

Multiply inch-pound	By	To obtain SI units
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

BASE-FLOW CHARACTERISTICS OF SEGMENTS OF THE PINEY RIVER, AND EAST AND WEST PINEY RIVERS, DICKSON AND HICKMAN COUNTIES, TENNESSEE

V. Jeff May

ABSTRACT

Base-flow discharge measurements, or observations of zero discharge, were made at 44 sites on the Piney River, East and West Piney Rivers, and principal tributaries in Dickson and Hickman Counties, central Tennessee, during a seepage investigation on August 28, 1984. This investigation was conducted to define the base-flow characteristics of those streams.

Six of the sites were base-flow partial-record stations on the main stems of the three rivers. Discharge measurements at those sites were correlated with concurrent discharge from the long-term gaging station Piney River at Vernon, Tennessee. The average 3-day minimum discharge with a 20-year recurrence interval was estimated from those correlation curves using an index value computed from 57 years of discharge record at the Vernon gage. Base-flow profiles showing discharge on August 28, 1984, and the 3-day 20-year minimum discharge along the Piney and East and West Piney Rivers were constructed.

Measured discharge on August 28, 1984, varied from 0.02 to 24.1 cubic feet per second on tributary streams, and from 4.16 to 96.1 cubic feet per second on the main stems of the three rivers. Zero discharge was observed at or near the mouth of 10 of the 24 tributary streams included in the seepage investigation. The 3-day 20-year minimum discharge, estimated for the six partial-record stations and computed for the Vernon gage, ranged from 2.4 cubic feet per second at the station on the East Piney River to 45.6 cubic feet per second at the Vernon gage, farthest station downstream. During base-flow conditions the Piney River, from river mile 16.1 upstream to river mile 23.6 (confluence of the East and West Piney Rivers), has several losing or gaining reaches of channel. The total discharge increase shown by the 3-day 20-year minimum base-flow profile in this 7.5 miles of river channel is 1.6 cubic feet per second. The minimum value of 6.5 cubic feet per second occurs at river mile 23.5. There is a substantial increase of 37.2 cubic feet per second in the 3-day 20-year minimum discharge from river mile 16.1 downstream to the Vernon gage, river mile 8.3.

INTRODUCTION

The Tennessee Department of Health and Environment, Division of Water Management (DWM), established a Task Force in 1984 to study the availability of water in the Piney River and its principal tributaries in the vicinity of Dickson, Tennessee. In cooperation with the DWM, the U.S. Geological Survey agreed to serve as a member of that Task Force and to aid in the collection and analyses of water data. Funded cooperative agreements between the City of Dickson, the DWM, and the Survey were developed to define work elements and to provide a budget for accomplishing the work.

As defined in the agreements and presented herein, the Survey collected base-flow discharge data and estimated the average 3-day minimum discharge with a 20-year recurrence interval (3Q20) for selected stream sites in the study area. These data and analyses can be used by water managers to determine water available during base-flow conditions.

DESCRIPTION OF AREA

The study area is located in Dickson and Hickman Counties, central Tennessee (fig. 1). The area includes that part of the Piney River basin which extends from the bridge over the Piney River at Vernon, Tennessee, upstream to the confluence of the East and West Piney Rivers and up those rivers to the first bridge crossing on each river (plates 1 and 2). The surface drainage area within the study boundary is 163 square miles and all of the area is part of the western Highland Rim physiographic province. Total surface drainage area in the Piney River basin upstream from the lower boundary at Vernon is 202 square miles.

STUDY METHODS

Data collection

Data were collected to define losing and gaining reaches of the Piney River and East and West Piney Rivers within the study area during base-flow conditions, and to estimate the 3Q20. Based on field reconnaissance of the basin, 44 stream sites were selected on the rivers and principal tributaries for making stream discharge measurements (table 1). Three of the 44 sites were existing base-flow partial-record stations, three were newly established partial-record stations, and one is the long-term continuous gaging station at Vernon, Tennessee. These seven stations were located on the main stems of the three rivers. All sites are plotted on the Dickson and Texas Hollow quadrangle maps shown as plates 1 and 2.

On August 28, 1984, base-flow discharge measurements were made at the 44 sites to determine losing and gaining reaches of the Piney River, and East and West Piney Rivers within the study area (table 2). This study, called a seepage investigation, included all principal streams in the Piney River basin from the Vernon gage (station 03602500) upstream to the confluence of the East and West Piney Rivers, and up those rivers to the first county road bridge on East Piney River (station 03602207), and to Tennessee Highway 48 on the West Piney River (station 03602192). Zero discharge was observed at or near the mouth of 10 of the 24 principal tributaries to the rivers. Over a period of several months in 1984, four or five additional measurements were made at the six partial-record stations and at the Vernon gage. In addition, several base-flow discharge measurements made in earlier years were available in Survey files for four of the partial-record stations on the rivers and for stations on many of the tributaries.

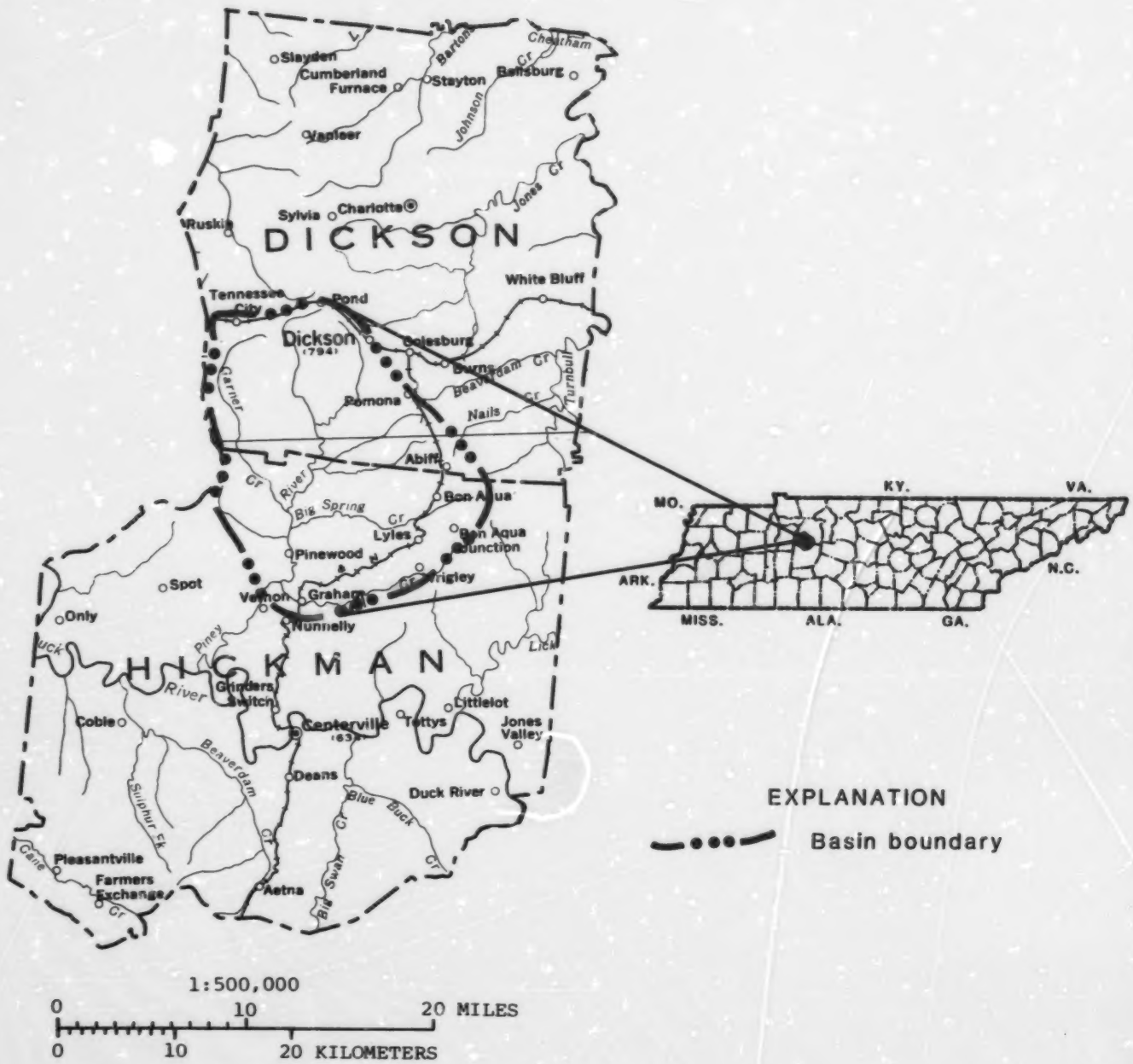


Figure 1.--Study area.

Table 1.--List of discharge measurement sites

Number	Name	Drainage area (mi^2)	Remarks
03602192	West Piney River near Dickson	21.2	Seepage and base-flow correlation.
0360219265	Dry Hollow Branch near Dickson	1.65	Seepage
036021927	West Piney River tributary at Highway 48 near Dickson.	.26	Seepage
03602193	Bruce Hollow Branch near Dickson	1.95	Seepage
03602194	West Piney River below State Highway 48 near Dickson.	25.7	Seepage and base-flow correlation.
03602207	East Piney River below Dickson	17.9	Seepage and base-flow correlation.
03602208	East Piney River below Donegan Cemetary near Dickson.	18.0	Seepage
036022087	Piney River tributary below Fielder Cemetary near Oak Grove.	.41	Seepage
03602209	Piney River near Oak Grove	44.1	Seepage and TVA biological study.
03602210	Gray Hollow Branch near Dickson	.73	Seepage
03602214	Piney River tributary near Oak Grove.	.51	Seepage
03602217	Piney River above I-40 near Oak Grove.	45.7	Seepage
03602220	Piney River below Dickson	46.7	Seepage and base-flow correlation.
03602221	Piney River below I-40 near Oak Grove.	46.7	Seepage
03602222	Double Branch near Oak Grove	1.30	Seepage
03602223	Wells Branch near Oak Grove	.77	Seepage
03602224	Piney River at County Line near Oak Grove.	--	Seepage

Table 1.--List of discharge measurement sites--Continued

Number	Name	Drainage area (mi^2)	Remarks
036022293	Bear Creek near Oak Grove	22.4	Seepage
036022294	Piney River below Bear Creek near Oak Grove.	72.6	Seepage
036022295	Piney River tributary near Meacham Cemetary near Oak Grove.	.27	Seepage
036022296	Piney River near Meacham Cemetary near Oak Grove.	73.3	Seepage
036022297	Piney River at County Road near Pinewood.	--	Seepage and TVA biological study.
036022299	Plunders Creek near Pinewood	3.40	Seepage
03602230	Piney River above Pinewood	77.5	Seepage and base-flow correlation.
036022303	Piney River tributary at Wrenn Hollow near Pinewood.	.63	Seepage
03602231	Piney River above Garner Creek near Pinewood.	78.8	Seepage
03602238	Garner Creek near Pinewood	27.6	Seepage
03602239	Piney River tributary below Garner Creek near Pinewood.	.13	Seepage
03602240	Piney River above Big Spring Creek near Pinewood.	107	Seepage
03602252	Big Spring Creek at mouth near Pinewood.	22.7	Seepage
03602254	Piney River tributary below Big Spring Creek near Pinewood.	.25	Seepage
03602258	Beaver Creek at Pinewood	10.4	Seepage
03602259	Piney River below Beaver Creek at Pinewood.	141	Seepage
03602261	Little Spring Creek at Pinewood.	8.80	Seepage

Table 1.--List of discharge measurement sites--Continued

Number	Name	Drainage area (mi^2)	Remarks
03602265	Piney River at Pinewood	150	Seepage and base-flow correlation.
03602269	Piney River tributary at Pinewood.	.58	Seepage
03602274	Keys Branch near Pinewood	2.84	Seepage
03602275	Piney River at Highway 48 near Pinewood.	--	Seepage
03602280	Piney River tributary at Cash Spring at Pinewood.	1.23	Seepage
03602420	Mill Creek near Pinewood	33.5	Seepage
03602422	Piney River at Matlock Ford near Pinewood.	191	Seepage
03602429	Piney River tributary below Matlock Ford near Pinewood.	.64	Seepage
03602430	Piney River below Matlock Ford near Pinewood.	192	Seepage
03602500	Piney River at Vernon	193	Gaging station

Table 2.--Seepage investigation data for August 28, 1984

A series of discharge measurements were made on August 28, 1984, on Piney River and tributaries including sections of East Piney River and West Piney River to define the low-flow hydrology and quality of water at base flow conditions. The reach studied included the main-stem and tributaries from mile 8.3 on the Piney River to mile 0.20 on the East Piney River and to mile 1.2 on the West Piney River. The measurements were made during a period of constant base flow. Tributary flow was considered a contribution and not a gain.

West Piney River mile	Site number and stream	Location	Drainage Area (mi^2)	Meas. disch. (ft^3/s)	West Piney River gain or loss	Water temp. (°C)	Specific conductance (μmhos/cm)
		Tennessee River Basin					
1.2	03602192 West Piney River	Lat 36°01'40", long 87°27'00", Dickson County, at State Highway 48 bridge, 2.3 miles northeast of Oak Grove, and at mile 1.2.	21.2	9.80	-	19.0	242
1.2	0360219265 Dry Hollow Branch	Lat 36°01'38", long 87°26'57", Dickson County, 2.4 miles northeast of Oak Grove, 4.8 miles southwest of Dickson, and 150 feet above mouth.	1.65	.24	-	18.5	288
1.1	036021927 West Piney River Tributary	Lat 36°01'32", long 87°27'05", Dickson County, at State Highway 48 culvert, 2.2 miles northeast of Oak Grove.	.26	0	-	-	-
.9	03602193 Bruce Hollow Branch	Lat 36°01'22", long 87°27'00", Dickson County, below county road bridge 2.1 miles northeast of Oak Grove and at mile 0.1.	1.95	0	-	-	-
0	03602194 West Piney River	Lat 36°00'43", long 87°26'33", Dickson County, at mouth, 5.4 miles southwest of Dickson.	25.7	10.4	+.36	18.5	248
.20	03602207 East Piney River	Lat 36°00'37", long 87°26'20", Dickson County, at county road bridge, 0.2 mile above West Piney River, 2.5 miles east of Oak Grove.	17.9	4.58	-	21.0	356
0	03602208 East Piney River	Lat 36°00'42", long 87°26'32", Dickson County, 20 feet above West Piney River, 5.4 miles southwest of Dickson.	18.0	4.16	-.42	21.5	316
23.6		Confluence of East and West Piney Rivers.					
Piney River mile					Piney River gain or loss		
23.6	036022087 Piney River Tributary	Lat 36°00'44", long 87°26'36", Dickson County, 2.2 miles east of Oak Grove, 5.4 miles southwest of Dickson, and 200 feet above mouth.	.41	0	-	-	-
23.5	03602209 Piney River	Lat 36°00'36", long 87°26'38", Dickson County, 2.2 miles east of Oak Grove.	44.1	13.9	-.66	20.0	280
23.4	03602210 Gray Hollow Branch	Lat 36°00'31", long 87°26'30", Dickson County, at county road bridge at mouth, 5.6 miles southwest of Dickson.	.73	0	-	-	-

Table 2.--Seepage investigation data for August 28, 1984--Continued

Piney River mile	Site number and stream	Location	Drainage Area (mi^2)	Meas. disch. (ft^3/s)	Piney River gain or loss	Water temp. (°C)	Specific conductance (µmhos/cm)
		Tennessee River Basin--Continued					
23.1	03602214 Piney River Tributary at Opossum Hollow.	Lat 36°00'15", long 87°26'43", Dickson County, at county road bridge, 2.1 miles east of Oak Grove at mile 0.2.	0.51	0.02	-	23.0	380
22.9	03602217 Piney River.	Lat 36°00'06", long 87°26'27", Dickson County, 2.4 miles east of Oak Grove and at mile 22.9.	45.7	17.0	+3.08	20.0	290
21.7	03602220 Piney River.	Lat 35°59'30", long 87°26'19", Dickson County, 2.7 miles southeast of Oak Grove.	46.7	17.0	0	20.0	290
21.5	03602221 Piney River.	Lat 35°59'24", long 87°26'06", Dickson County, 5.8 miles north of Pinewood, 2.9 miles southeast of Oak Grove, and at mile 21.5.	46.7	15.8	-1.20	20.0	290
21.5	03602222 Double Branch nr Oak Grove.	Lat 35°59'24", long 87°26'24", Dickson County, 2.9 miles southeast of Oak Grove, and 50 feet above mouth.	1.30	.26	-	19.0	255
21.1	03602223 Wells Branch.	Lat 35°59'20", long 87°26'19", Dickson County, at county road bridge, 2.8 miles southeast of Oak Grove, and at mile 0.1.	.77	0	-	-	-
20.6	03602224 Piney River.	Lat 35°58'56", long 87°26'37", Hickman County, 1.0 mile upstream of Bear Creek, 2.6 miles southeast of Oak Grove, and at mile 20.6.	--	16.1	+.04	20.0	285
19.5	036022293 Bear Creek.	Lat 35°58'30", long 87°26'48", Hickman County, 2.9 miles southeast of Oak Grove, 5.0 miles north of Pinewood, and 150 feet above mouth.	22.4	2.29	-	20.5	265
19.5	036022294 Piney River.	Lat 35°58'25", long 87°26'45", Hickman County, 300 feet below Bear Creek, 3.0 miles southeast of Oak Grove, and at mile 19.5.	72.6	23.7	+5.31	21.0	280
19.1	036022295 Piney River Tributary.	Lat 35°58'10", long 87°26'54", Hickman County, at county road bridge, 3.2 miles southeast of Oak Grove, and at mile 0.2.	.27	0	-	-	-
18.7	036022296 Piney River.	Lat 35°57'53", long 87°27'03", Hickman County, 3.5 miles southeast of Oak Grove, 3.8 miles north of Pinewood, and at mile 18.7.	73.3	23.1	-.60	21.5	280
18.0	036022297 Piney River.	Lat 35°57'33", long 87°27'31", Hickman County, 0.2 mile above Plunders Creek, 3.4 miles north of Pinewood, and at mile 18.0.	--	21.1	-2.00	21.0	310
17.8	036022299 Plunders Creek.	Lat 35°57'39", long 87°27'43", Hickman County, 3.4 miles north of Pinewood, 3.4 miles south of Oak Grove, and 100 feet above mouth.	3.40	.71	-	19.0	280

Table 2.--Seepage investigation data for August 28, 1984--Continued

Piney River mile	Site number and stream	Location	Drainage Area (mi^2)	Meas. disch. (ft^3/s)	Piney River gain or loss	Water temp. (°C)	Specific conductance (µmhos/cm)
		Tennessee River Basin--Continued					
17.2	03602230 Piney River.	Lat 35°57'11", long 87°27'53", Hickman County, at county road crossing, 0.7 mile below mouth of Plumders Creek, 2.8 miles north of Pinewood and at mile 17.2.	77.5	25.2	+3.39	20.0	260
16.9	036022303 Piney River Tributary at Wrenn Hollow.	Lat 35°57'03", long 87°27'55", Hickman County, at county road bridge, 2.7 miles north of Pinewood, and at mile 0.1.	.63	0	-	-	-
16.1	03602231 Piney River.	Lat 35°56'34", long 87°28'08", Hickman County, 200 feet above Garner Creek, 2.1 miles north of Pinewood, and at mile 16.1.	78.8	25.7	+.50	20.0	260
16.1	03602238 Garner Creek.	Lat 35°56'32", long 87°28'08", Hickman County, 2.1 miles north of Pinewood, and 100 feet above mouth.	27.6	6.18	-	20.0	240
15.7	03602239 Piney River Tributary.	Lat 35°56'23", long 87°27'56", Hickman County, at county road bridge, 2.0 miles north of Pinewood, and 350 feet above mouth.	.13	0	-	-	-
15.2	03602240 Piney River.	Lat 35°55'56", long 87°28'05", Hickman County, at county road bridge, 1.4 miles north of of Pinewood, and at mile 15.2.	107	36.2	+4.32	20.0	275
15.1	03602252 Big Spring Creek.	Lat 35°55'53", long 87°28'04", Hickman County, 1.4 miles north of Pinewood, and 100 feet above mouth.	22.7	12.4	-	18.0	245
15.0	03602254 Piney River Tributary.	Lat 35°55'48", long 87°28'11", Hickman County, at county road bridge, 1.3 miles north of Pinewood, and 200 feet above mouth.	.25	0	-	-	-
14.6	03602258 Beaver Creek.	Lat 35°55'26", long 87°28'23", Hickman County, 0.9 mile north of Pinewood, and 100 feet above mouth.	10.4	2.96	-	19.0	240
14.5	03602259 Piney River.	Lat 35°55'21", long 87°28'24", Hickman County, 450 feet below Beaver Creek, 0.8 mile north of Pinewood, and at mile 14.5.	141	51.9	+.34	20.5	240
13.6	03602261 Little Spring Creek.	Lat 35°54'39", long 87°28'00", Hickman County, 0.2 mile east of Pinewood, and 150 feet above mouth.	8.80	1.58	-	21.5	210
13.5	03602265 Piney River.	Lat 35°54'37", long 87°28'04", Hickman County, at county road crossing, 200 feet below mouth of Little Spring Creek, at Pinewood, and at mile 13.5.	150	57.2	+3.72	21.0	240
13.4	03602269 Piney River Tributary.	Lat 35°54'35", long 87°28'08", Hickman County, at county road bridge, 0.1 mile south of Pinewood, and 300 feet above mouth.	.58	0.00	-	-	-

Table 2.--Seepage investigation data for August 28, 1984--Continued

Piney River mile	Site number and stream	Location	Drainage Area (mi^2)	Meas. disch. (ft^3/s)	Piney River gain or loss	Water temp. (°C)	Specific conductance (µmhos/cm)
		Tennessee River Basin--Continued					
11.5	03602274 Keys Branch.	Lat 35°53'26", long 87°28'09", Hickman County, 1.4 miles south of Pinewood, 2.9 miles north of Nunnelly, and 150 feet above mouth.	2.84	1.48	-	19.5	215
11.5	03602275 Piney River.	Lat 35°53'25", long 87°28'12", Hickman County, at State Highway 48 bridge, 1.5 miles south of Pinewood, and at mile 11.5.	--	64.3	+5.62	22.5	185
10.9	03602280 Piney River Tributary at Cash Spring	Lat 35°53'50", long 87°28'50", Hickman County, at county road bridge, 1.1 miles south of Pinewood, and at mile 0.4.	1.23	.10	-	20.0	165
10.7	03602420 Mill Creek.	Lat 35°53'25", long 87°28'50", Hickman County, 1.6 miles south of Pinewood, and 200 feet above mouth.	33.5	24.1	-	20.5	200
10.6	03602422 Piney River.	Lat 35°53'23", long 87°28'55", Hickman County, at Matlock Ford, 1.6 miles south of Pinewood, and at mile 10.6.	191	94.3	+5.80	21.0	245
10.2	03602429 Piney River Tributary below Matlock Ford.	Lat 35°53'26", long 87°29'22", Hickman County, 1.8 miles southwest of Pinewood, and at mouth.	.64	0	-	-	-
10.1	03602430 Piney River.	Lat 35°53'25", long 87°29'23", Hickman County, 0.4 mile west of Matlock Fork, 1.8 miles southwest of Pinewood, and at mile 10.1.	192	93.9	-.40	21.0	230
8.3	03602500 Piney River.	Gaging Station at Vernon (03602500).	193	96.1	+2.20	20.5	235

Water temperature and specific conductance readings were obtained at all sites where discharge measurements were made. These data are routinely collected by the U.S. Geological Survey in Tennessee for all discharge measurements made during seepage investigations and at partial-record stations. They were not used in defining the base-flow characteristics of the streams in the study area but are presented for further reference or for possible future needs.

Data analysis

Base-flow measurements of the Piney River, East and West Piney Rivers and tributaries during the seepage investigation on August 28, 1984, were used to construct base-flow discharge profiles (plates 3 and 4). Those profiles show discharge along the river channels, losing and gaining channel reaches, and the contribution of water from the principal tributaries. The profiles can be used to help estimate the response of the streams when rainfall is deficient.

Base-flow measurements made in 1984, and available in Survey files for the partial-record stations, were used with concurrent measurements at the Vernon gage to construct a base-flow discharge correlation curve for each station. A representative curve is shown in figure 2. Using 57 years of recorded continuous discharge at the Vernon gage, a statistical base-flow discharge referred to as the average 3-day minimum discharge with a recurrence interval of 20 years (3Q20) was computed for the gage. The 3Q20 is the base-flow discharge used by state and federal agencies in Tennessee for water management planning. The 3Q20 for the six partial-record stations was determined by entering the respective correlation curves with the Vernon gage 3Q20. Values for each station are listed in table 3.

The 3Q20 and the base-flow profiles for August 28, 1984, were used to construct 3Q20 profiles for the Piney River and East and West Piney Rivers (plates 3 and 4). Base-flow measurements and 3Q20 estimates available in Survey files for some tributaries were also used to aid in computing the 3Q20 contribution from those tributaries. The shape of the profiles between computed values (seven station plots) was estimated based on the August 28 profile, tributary inflow, drainage areas, geology, and information on channel and flood-plain characteristics. Information on how basin and channel characteristics affect or control base flow can be obtained in publications listed in the "SELECTED REFERENCES" section.

Estimates of the 3Q20 discharge at any selected point on the Piney River and East and West Piney Rivers included in this study can be read directly from the profiles. Straight-line segments of the profiles reflect an assumption that there is a uniform rate of discharge gain or loss along that channel reach. This is not always the case. The important characteristic shown by the profiles is the net gain or loss between measured points.

Using the 3Q20 as a base for comparisons, the water available in the Piney River and East and West Piney Rivers within the study area varies significantly along the river channels. The estimated discharge at the mouth of the East Piney River is 2.0 ft^3/s which is less than the 2.4 ft^3/s at the partial-record

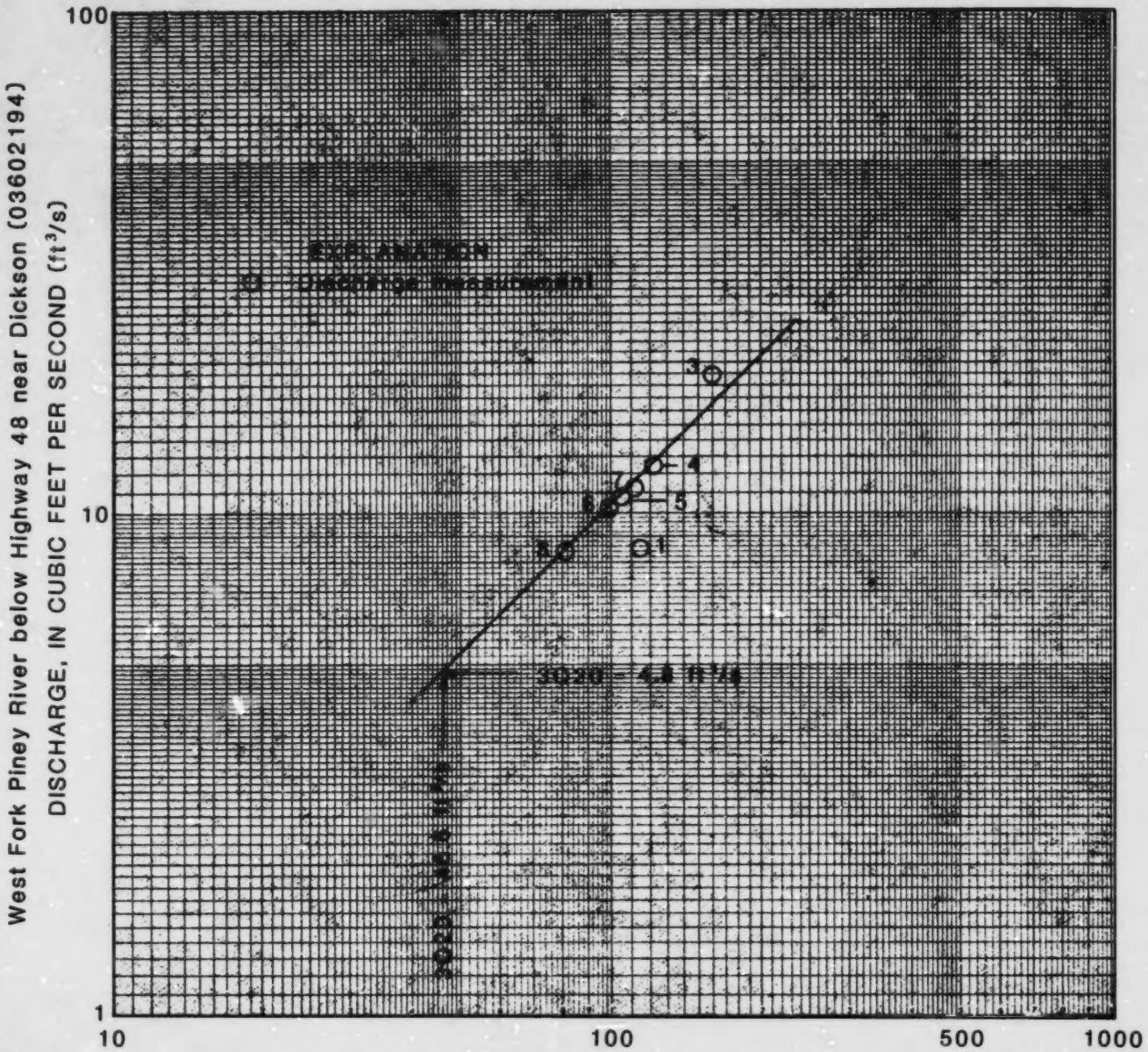


Figure 2.--Base-flow discharge correlation curve.

Table 3.--Average 3-day minimum discharge, 20-year recurrence interval, at partial-record stations and Vernon gage

Station number	Station name	Drainage area (mi^2)	Average 3-day minimum discharge, 20-year recurrence interval (ft^3/s)	Remarks
03602192	West Piney River near Dickson.	21.2	5.0	Partial-record station
03602194	West Piney River below State Highway 48 near Dickson.	25.7	4.8	Partial-record station
03602207	East Piney River below Dickson.	17.9	2.4	Partial-record station
03602220	Piney River below Dickson.	46.7	8.4	Partial-record station
03602230	Piney River above Pinewood.	77.5	9.1	Partial-record station
03602265	Piney River at Pinewood.	150	19	Partial-record station
03602500	Piney River at Vernon.	193	45.6	Gaging station

station 0.2 river mile above the mouth. At the mouth of the West Piney River the 3Q20 is 4.8 ft^3/s which is less than the 5.0 ft^3/s at the partial-record station 1.2 river miles upstream but 2.4 times the 3Q20 at the mouth of East Piney River. The lower reaches of channel for both streams apparently are losing reaches during base-flow conditions.

The estimated 3Q20 base flow along the Piney River varies from 6.5 ft^3/s at river mile 23.5, 0.1 mile downstream from the confluence of the East and West Piney Rivers, to 45.6 ft^3/s at the Vernon gage, river mile 8.3. The discharge at river mile 16.1, just above Garner Creek, is 8.4 ft^3/s which shows a cummulative gain of 1.9 ft^3/s from river mile 23.5 for 7.4 miles of river channel. The maximum 3Q20 between those two points is 9.5 ft^3/s at river mile 19.5 just downstream from Bear Creek. There are several losing and gaining reaches of channel within that 7.4 mile reach. Of the 24 tributaries measured on August 28, 1984, only five contributed 3Q20 base flow. Bear Creek is the only tributary that contributes 3Q20 base flow from the confluence of the East and West Piney Rivers, at Piney River mile 23.6, to Piney River mile 16.1. Garner, Big Spring, Beaver, and Mill Creeks are the other tributaries measured that contribute 3Q20 base flow. Significant increases in the 3Q20 occur along the Piney River channel, and from the large tributaries, downstream from river mile 16.1 to the Vernon gage, river mile 8.3. The cummulative 3Q20 base flow within that channel reach is 37.2 ft^3/s.

A comparison of base flow on August 28, 1984, to mean August discharges for the period of record at the Vernon gage is shown in figure 3. The measurement made at the gage on August 28 was 96.1 ft^3/s and the mean discharge for August 1984 was 110 ft^3/s. The mean of all August discharges for the 60 years of record (1925-84) is 116 ft^3/s. The mean August discharge for the last 25 years (1960-84) is 131 ft^3/s. The measurements made on August 28, 1984, at the six partial-record stations and the Vernon gage are compared to mean August discharge for various periods in table 4. That comparison shows that there was no detectable surface runoff from rainfall in the streams measured on August 28. All streams were well within that range of discharge called base flow.

A flow-duration curve is a cummulative frequency curve that shows the percentage of time that specified discharges are equaled or exceeded. The flow-duration curve for 1926-84 for the Vernon gage is shown on figure 4. The discharge of 96.1 ft^3/s measured on August 28, 1984, was exceeded 70 percent of the time during that period. As shown on figure 4, the mean August flow of 110 ft^3/s for 1984 was exceeded 65 percent of the time.

Based on comparisons to long-term discharges at the Vernon gage, the discharges measured on August 28, 1984, reflect base-flow conditions for this study and analyses.

SUMMARY

Base-flow conditions existed on August 28, 1984, for the seepage investigation along segments of the Piney River, East and West Piney Rivers, and tributaries included in the study area. The base-flow data and analyses can

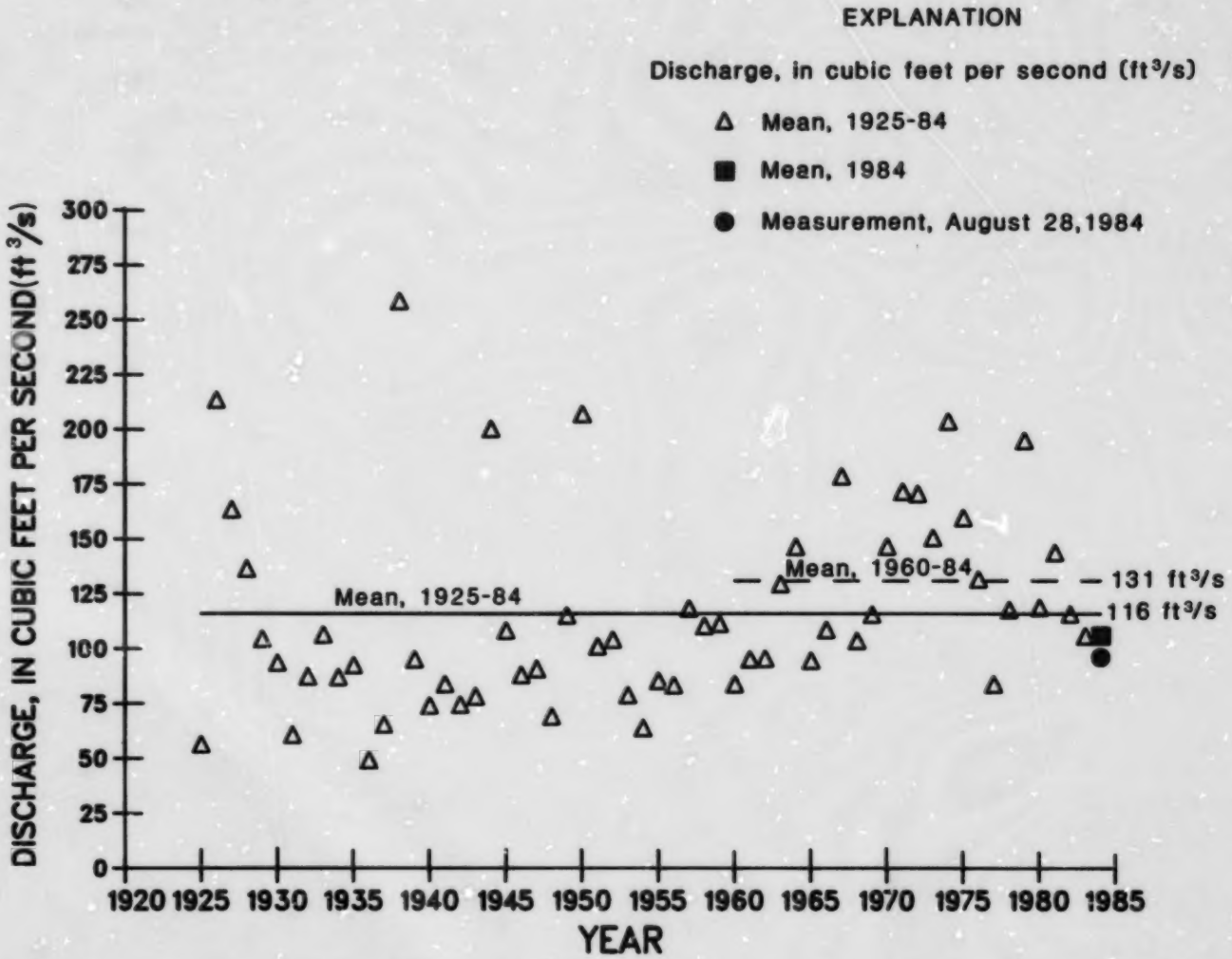


Figure 3.--August discharge for gaging station Piney River at Vernon (03602500).

Table 4.--August discharge at partial-record stations and Vernon gage

Number	Name	Drainage area (mi^2)	River mile (from mouth)	Measurement on August 28, 1984 (ft^3/s)	Estimated August mean discharge (ft^3/s) 1984	1960-84	1925-84	Station
03602192	West Piney River near Dickson.	21.2	1.2	9.80	12	15	13	Partial record
03602194	West Piney River below State Highway 48 near Dickson.	25.7	0.0	10.4	12	14	12	Partial record
03602207	East Piney River below Dickson.	17.9	.2	4.58	6	7	6	Partial record
03602220	Piney River below Dickson.	46.7	21.7	17.0	19	23	20	Partial record
03602230	Piney River above Pinewood.	77.5	17.2	25.2	32	42	35	Partial record
03602265	Piney River at Pinewood.	150	13.5	57.2	71	92	78	Partial record
					Recorded August mean discharge (ft^3/s)			
03602500	Piney River at Vernon.	193	8.3	96.1	110	131	116	Gaging station

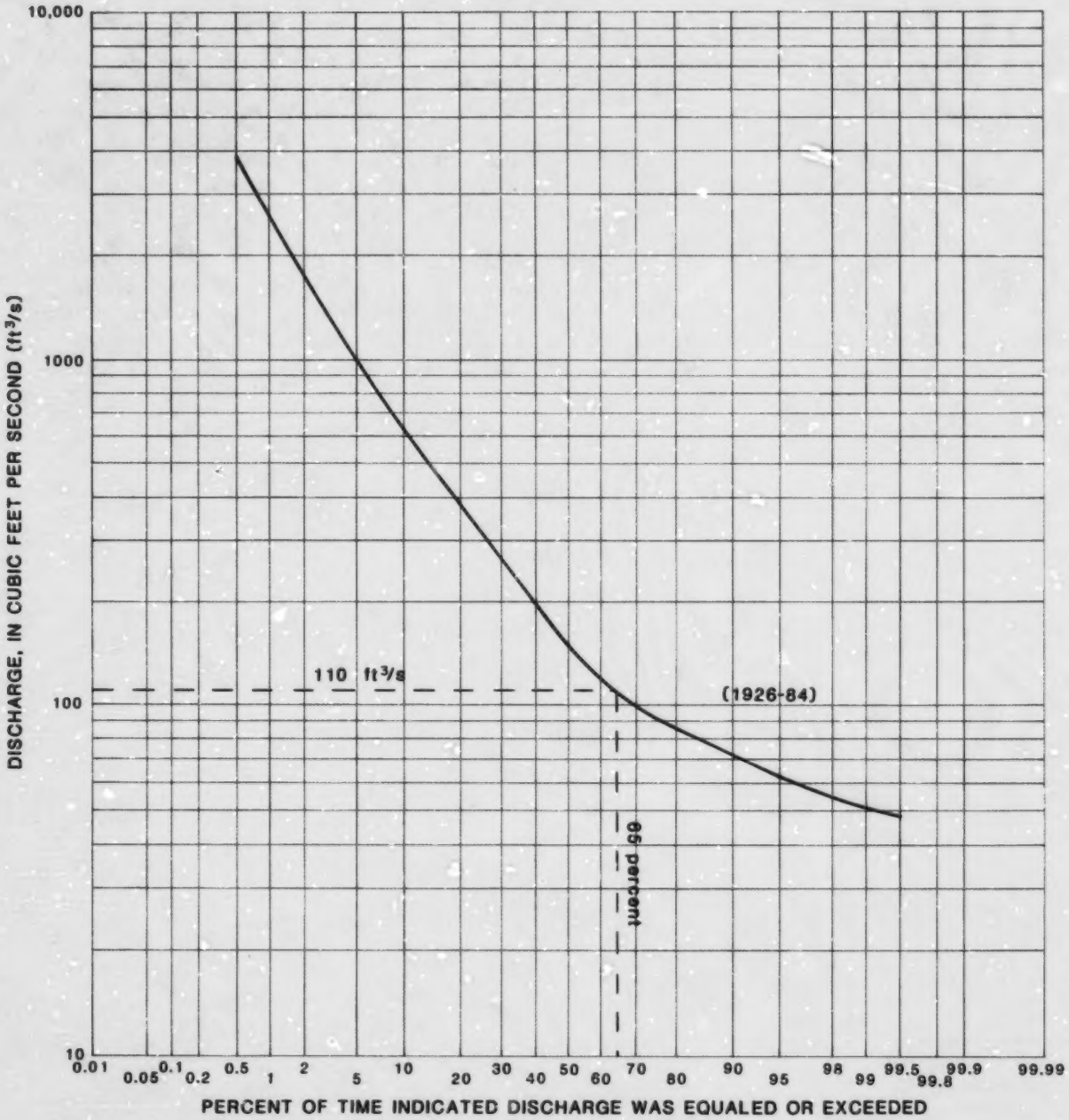


Figure 4.--Flow-duration curve for gaging station Piney River at Vernon (03602500).

be used by water managers to estimate streamflow in that part of the basin covered by this study.

Discharge in the Piney River and East and West Piney Rivers during base-flow conditions is variable from site to site within the study area. The average 3-day minimum discharge with a recurrence interval of 20-years is zero in most tributary streams. The West Piney River has 2.4 times more water at the mouth (4.8 ft^3/s) than does the East Piney River (2.0 ft^3/s), based on a 3-day 20-year recurrence interval discharge. The smallest 3-day 20-year recurrence interval discharge of 6.5 ft^3/s on the Piney River occurs at river mile 23.5, 0.1 river mile below the confluence of the East and West Piney Rivers. From that point downstream to river mile 16.1, there are several losing or gaining channel reaches, and an accumulated discharge of 8.4 ft^3/s, 1.9 ft^3/s larger than at river mile 23.5. The Piney River from river mile 16.1 downstream to the Vernon gage at river mile 8.3 is a prolific stream during base-flow conditions. There is an increase of 37.2 ft^3/s within that 7.8 miles of river channel. Garner, Big Spring, and Mill Creeks also have significant sustained base flows.

SELECTED REFERENCES

Bingham, R. H., 1982, Low-flow characteristics of Alabama streams: U.S. Geological Survey Water-Supply Paper 2083, 27 p.

_____1985, Low flows and flow duration of Tennessee streams through 1981: U.S. Geological Survey Water-Resources Investigations Report 85-4347, 325 p.

Bradley, M. W., 1984, Ground water in the Dickson area of the western Highland Rim of Tennessee: U.S. Geological Survey Water-Resources Investigations Report 82-4088, 42 p.

Gold, R. L., 1980, Low flow measurements of Tennessee streams: Tennessee Department of Conservation, Water Resources Division, Water Resources Series no. 14, 362 p.

_____1981, Low-flow frequency and flow duration of Tennessee streams: U.S. Geological Survey Open-File Report 78-807, 361 p.

Marcher, M. V., Bingham, R. H., and Lounsbury, R. E., 1964, Ground-water geology of the Dickson, Lawrenceburg, and Waverly areas in the Western Highland Rim, Tennessee: U.S. Geological Survey Water-Supply Paper 1764, 50 p.

May, V. J., Wood, G. H., and Rima, D. R., 1970, A proposed streamflow-data program for Tennessee: U.S. Geological Survey open-file report, 108 p.

Riggs, H. C., 1972, Low-flow investigations: U.S. Geological Survey Techniques of Water Resources Investigations, Book 4, Chapter B1, 18 p.

Searcy, J. K., 1959, Flow-duration curves, in Manual of Hydrology: Part 2. Low-flow techniques: U.S. Geological Survey Water-Supply Paper 1542-A, 33 p.

U.S. Geological Survey, 1965-1983, Water resources data for Tennessee: U.S. Geological Survey Water-Data Report, issued annually.

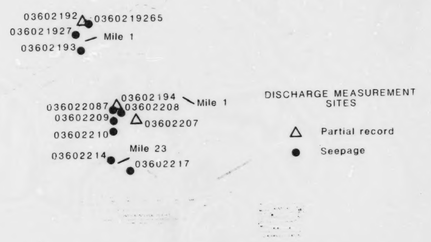
UNITED STATES DEPARTMENT
OF THE INTERIOR
GEOLOGICAL SURVEY

Prepared in cooperation with the
CITY OF DICKSON
and the
TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT,
DIVISION OF WATER MANAGEMENT

OPEN-FILE REPORT 85-155
PLATE 1

87°30'
36°07'30"

87°22'30"



Base from U.S. Geological Survey
1:24,000, 1953
Photorevision as of 1968

Plate 1.--Measurement sites on Dickson quadrangle.

best copy available

UNITED STATES DEPARTMENT
OF THE INTERIOR
GEOLOGICAL SURVEY

Prepared in cooperation with the
CITY OF OAKDALE
and the
TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT,
DIVISION OF WATER MANAGEMENT

OPEN-FILE REPORT 85-155
PLATE 2

DISCHARGE MEASUREMENT SITES

- ▲ Gaging station
- △ Partial record
- ● Seepage

Plate 2.--Measurement sites on Texas Hollow quadrangle.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Prepared in cooperation with the
CITY OF DICKSON
and the
TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT,
DIVISION OF WATER MANAGEMENT

OPEN-FILE REPORT 85-155
PLATE 3

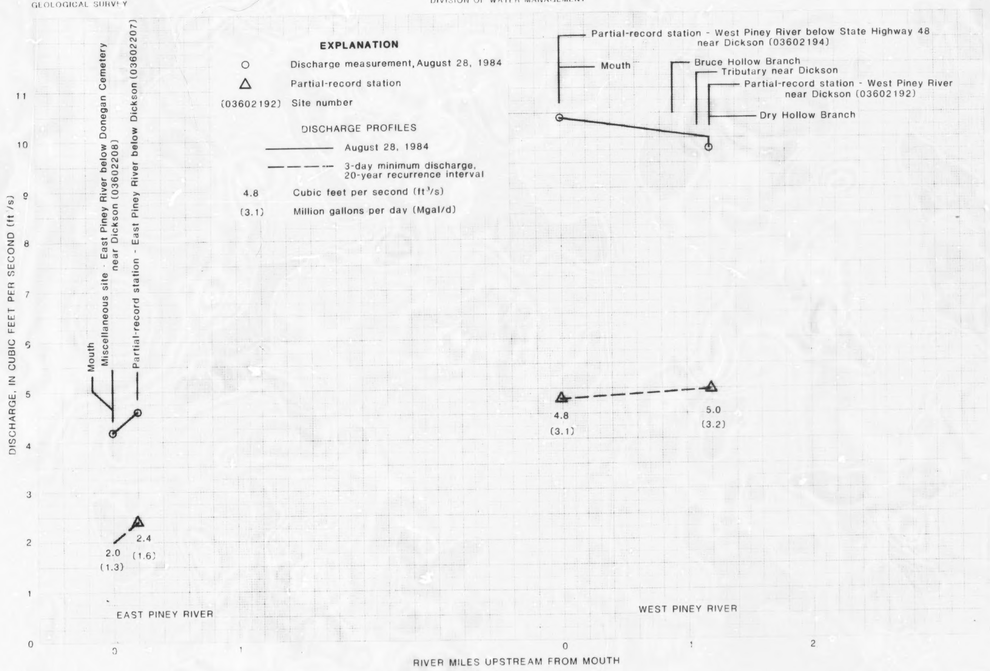
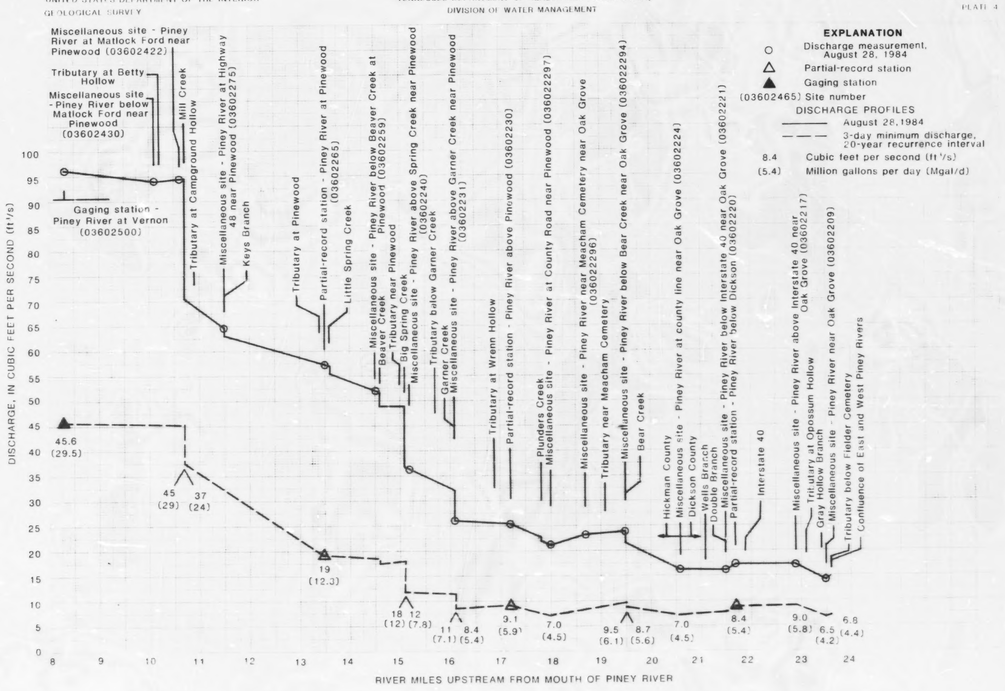

EXPLANATION
Discharge measurement, August 28, 1984
Partial-record station
(03602192) Site number
DISCHARGE PROFILES
August 28, 1984
3-day minimum discharge, 20-year recurrence interval
4.8 Cubic feet per second (ft³/s)
(3.1) Million gallons per day (Mgal/d)
Partial-record station - West Piney River below State Highway 48 near Dickson (03602194)
Mouth
Bruce Hollow Branch Tributary near Dickson
Partial-record station - West Piney River near Dickson (03602192)
Dry Hollow Branch
Mouth
Miscellaneous site - East Piney River below Donegan Cemetery near Dickson (03602208)
Partial-record station - East Piney River below Dickson (03602207)
4.8 (3.1)
5.0 (3.2)
2.0 (1.3)
2.4 (1.6)
DISCHARGE, IN CUBIC FEET PER SECOND (ft³/s)
EAST PINEY RIVER
WEST PINEY RIVER
RIVER MILES UPSTREAM FROM MOUTH

Plate 3.--Base-flow profiles for East and West Piney Rivers.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Prepared in cooperation with the
CITY OF DICKSON
and the
TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT,
DIVISION OF WATER MANAGEMENT

OPEN-FILE REPORT 85-155
PLATE 4



EXPLANATION

- ○ Discharge measurement, August 28, 1984
- △ Partial-record station
- ▲ Gaging station
- (03602465) Site number

DISCHARGE PROFILES

- ——— August 28, 1984
- — — — 9-day minimum discharge, 20-year recurrence interval
- 8.4 Cubic feet per second (ft³/s)
- (5.4) Million gallons per day (Mgal/d)

Plate 4.--Base-flow profiles of Piney River.